Transparency_2

Annie Luciani, Jean-Loup Florens

Transparency_2

Annie Luciani [ACROE&INPG]
Jean-Loup Florens [ACROE&INPG]

In the mechanical manipulation chain, we act on a physical object that is a part of the physical universe through a physical interaction. The performer and the object are present within the same space, at physical, perceptual and cognitive levels. Fifty years ago, the manipulation of dangerous materials, such as nuclear materials, began to implement the need of a distant manipulation, setting-up two different spaces: the user's space and the task's space. Once the direct physical communication has been replaced by electrical communication between the two spaces, once both spaces become distant, the classical teleoperation instrument is transformed in a more complex manipulation chain [→ Teleoperation / telepresence / telesymbiosis]. Basically, the instrument has been decomposed in three parts: a part which is in the user's space, a part which is in the task's space and a part that support the communication between them. The question of transparency got into the way.

Transparency in robotics/teleoperation

In robotics and teleoperation, the paradigm of transparency seeks at evaluating the identity of the mechanical manipulation chain as compared to the electrified, decomposed. Transparent is understood as: "The components added when electrifying the manipulation chain have to behave as if they did not exist", or, similarly, "they should allow producing the same man/environment interaction as in the direct natural interaction situation". Ideally, a transparent manipulation chain has to be identical to the reference situation.

In the aim of designing such transparent teleoperation components, a more technical definition of transparency has been proposed, which is founded on the equality of two impedances: on one side the impedance Zc of the remote environment seen by the teleoperation medium; and on the other side the impedance Z of the teleoperation medium as seen by the human. The teleoperation chain is transparent if and only if $Z=Zc$.

Anyhow, in Robotics, transparency is only an ideal specification that is unreachable. It means in particular that the teleoperation link should transmit instantaneously from one side to the other the mechanical constraints created by the interacting protagonists (the human and the environment). Because of the inherent lags of digital signal transmission systems, this is not possible. In addition, the mechanical parts on the two sides of the teleoperator system cannot be completely neutralized by any active control system. In these conditions, obtaining a good transparency simply consists in minimising the impedance error Z-Zc while preserving acceptable trade off with stability. In these conditions, the functional properties of the remaining non-transparent part of the human environment medium cannot be considered. Hence, the meaning of transparency that developed in the field of Robotics works at the phenomenological analysis level, using notions originated in control-command paradigms, such as error minimization, stability, etc. In VR, the usual understanding of the concept of transparency can be viewed an extension of the transparency in real-real teleoperation.

An instrumental to the notion of transparency

Conversely, in the instrumental paradigm [Cadoz, 1994], the new chain is considered as a new instrument. Consequently, the true goal is the design of the instrument so that the user is able to perform a task, rather than trying to make the new instrument similar to a hypothetical previous one. This is related to an anthropological point of view of the notion of instrument – or tool –, saying that instruments are designed as to have functional features allowing a human to perform

a task (for a discussion, see [→ Action fidelity]). An instrument is designed as an adaptor to human capabilities, including learning and human adaptation. This vision assumes that there is no necessity of an instrumental reference that would be a priori the best to perform the task. It leads to investigate new methods for designing and implementing such new instruments – a kind of new ergonomics. The computer-based technologies such as simulation are considered as one of them. The research activity shifts from the measure of the similarity between two instrumental chain, and the transparency of the new instrument to the investigation of the properties of the man / instrument / manipulated object (if any) chain.

Transparency in the instrumental approach, hence, shifts from the specification of transparency introduced in teleoperation. The new instrument is considered as an intermediate object that can be physically characterized in order to reach the best adaptation possible with the humans and with the task. This approach fits more to the Leroi-Gourhan [Leroi-Gouhan, 1964], anthropologist & philosopher, in which there is no importance for an instrument to be transparent in the sense of the teleoperation chain. The most important point is that instrument design must be guided by considering that a new instrument must realize the best adaptation between human's capabilities and the new task. In other words, the first functionality of an instrument is to be a necessary intermediate between human and world.

The instrument: a second nature

This leads to introduce an instrumental approach to the concept of transparency. An instrument is the result of a technical, material and cognitive process in which an object is transformed to adapt humans and physical world in order to perform tasks. This process is intimately accompanied by several others in the operator himself: learning, appropriation, and finally embodiment. The ultimate point of the process of becoming an instrument, and reciprocally becoming an instrumentalist, is when the instrument has successfully become a second nature, a prolongation of the human organology, being really transparent in the sense of being usable in an intimate and non-conscious manner by instrumentalists, craftsmen, artists, and dexterous users [→ Transparency_1].

References

[Cadoz, 1994] Cadoz C. "Le geste, canal de communication homme/machine. La communication instrumentale" - Technique et science de l'information. Volume 13 - n° 1/1994, pages 31-61.

[Leroi-Gouhan, 1964] Leroi Gourhan A. Translation of "Le geste et la parole, 2 vols. Albin Michel eds. Paris. 1964–65). Enlish translation "Gesture and Speech". Cambridge, Massachusetts & London: MIT Press, 1993.

Related items

Action fidelity
Teleoperation / telepresence / telesymbiosis
Transparency_1
Transparency_3